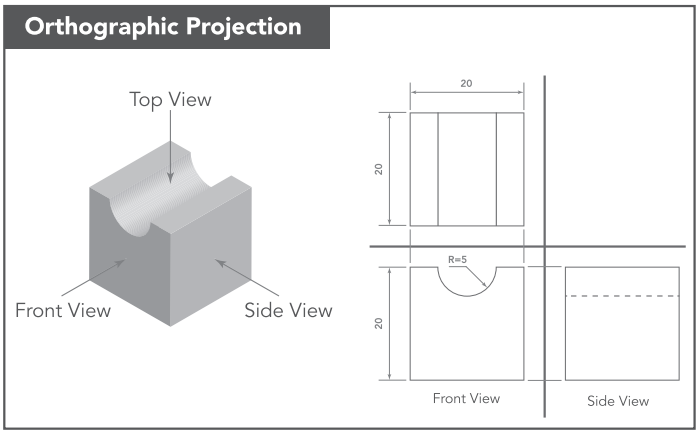
Orthographic Projection: Multiview

ORTHOGRAPHIC PROJECTION is a common technique used to produce mechanical and architectural CAD drawings. Multiview orthographic projection drawings allow the drafter to represent a 3D drawing in a 2D environment. Multiview drawings can consist of up to six principal views: front, back, top, bottom, left side, and right side. Most multiview drawings have three principal views, but more views may be shown for complex objects with lots of details.



Objective:

Examine multiview orthographic projections and draw the six principal views.

Key Terms:

axonometric projection
back view
bottom view
cabinet
cavalier
diametric projection
front view
general
glass box technique
isometric projection
left side view
line of sight
linear perspective
line precedence
multiview orthographic projection
oblique projection
one-point perspective
orthographic projection
plane of projection
projection theory
right side view
six principal views
three-point perspective
top view
trimetric projection
two-point perspective

Drawing Multiview Orthographic Projections

Orthographic projection is a method to represent three-dimensional (3D) objects in two dimensions (2D): a series of separate 2D inter-related views. Orthographic projection is a

parallel projection technique where the plane of projection is positioned between the observer and the object and is perpendicular to the parallel lines of sight. This technique is used to produce pictorial drawings that show all three dimensions of an object or multiviews that only show two dimensions of an object in a single view.

The difference between orthographic projection and any other method is the use of 2D views of the object instead of a single view. Orthographic projection (drawings) helps overcome the challenge of viewing 3D objects' six faces. Orthographic drawings are used to provide a manufacturer or fabricator an accurate, measured, drawing that can be followed when making an object. Engineers used orthographic projection to create multiview drawings.

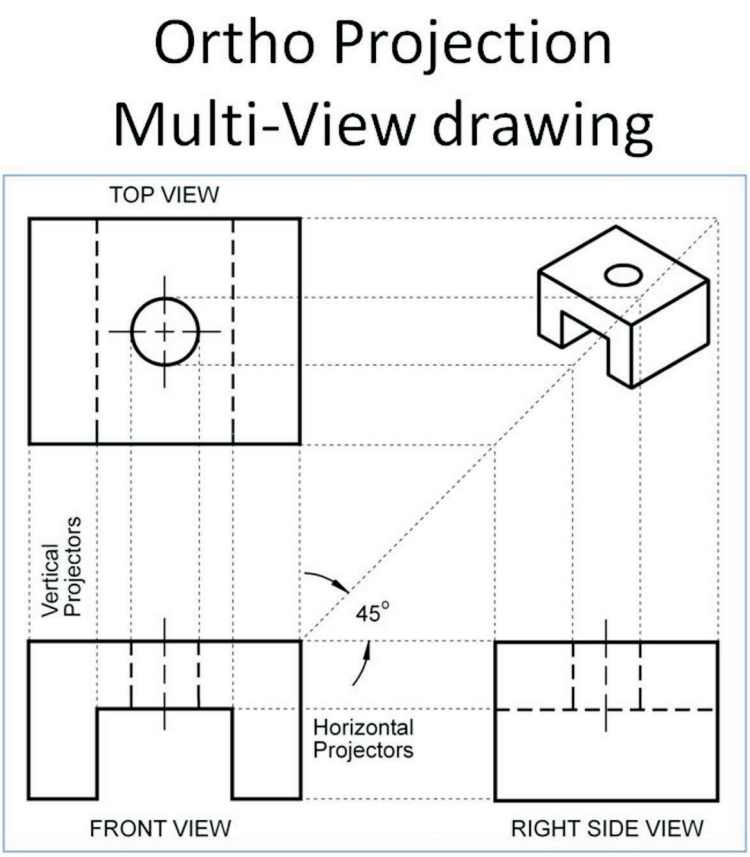


FIGURE 1: This image shows an orthographic multiview projection drawing. (Image Courtesy: Mark Smith, Industrial Technology Instructor, Reed-Custer High School, Braidwood, IL)

MULTIVIEW ORTHOGRAPHIC PROJECTIONS

A **multiview orthographic projection** is a drawing technique in which up to six images of an object are produced (illustrated). With each drawing the object is behind the plane of projection and the object is positioned in such a way that only two of its dimensions are shown. The parallel lines of sight go through the projection plane and the features of the part are outlined. Perspectives in orthographic and multiview projections include: linear, axonometric, and oblique types.

Linear Perspective

A **linear perspective** (drawing) is a system that creates an illusion of depth on a flat surface. All parallel lines in a linear perspective drawing use this system to unite all lines to a single or multiple vanishing points on a horizon line. There are three types of linear perspective: one-, two-, and three-point perspectives.

- **One-point perspective** is a projection system that uses a single vanishing point to create the illusion of depth in a drawing.

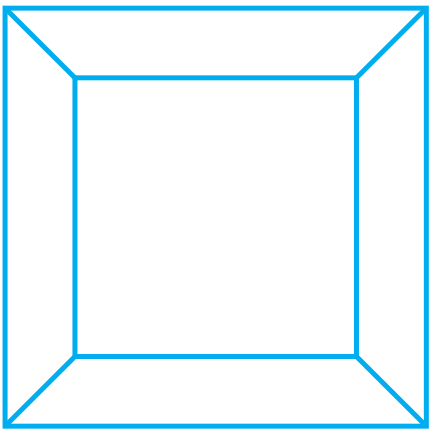


FIGURE 2. This drawing is an example of 1-point perspective.

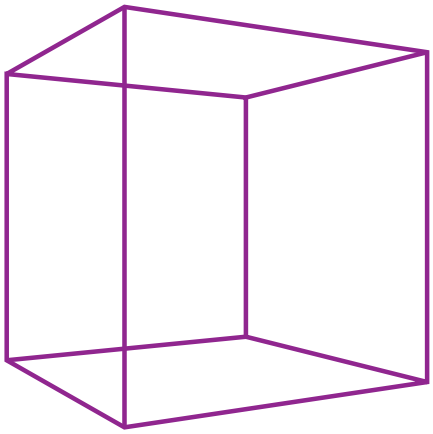


FIGURE 3. This drawing is an example of 2-point perspective.

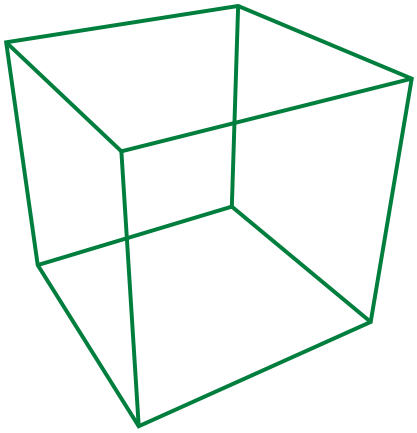


FIGURE 4. This drawing is an example of 3-point perspective.

- **Two-point perspective** is a projection system that uses two vanishing points to create the illusion of depth in a drawing. Two-point perspective gives a more realistic view of an object than 1-point perspective.
- **Three-point perspective** is a projection system that uses three vanishing points to create the illusion of depth in a drawing. This system can have three types of perspective:
  - Bird's eye view
  - Ground's eye view
  - Worm's eye view

Axonometric Projection

An **axonometric projection** is a type of orthographic projection used to create a pictorial drawing, where lines of sight are perpendicular to the plane of projection and the object is rotated around one or more of its axes to show multiple sides. There are three types of axonometric projections: isometric, diametric, and trimetric.

- An **isometric projection** is a pictorial representation of an object in which all three coordinate axes appear equally foreshortened and the angle between any two of them is 120 degrees. Isometric projection is the most commonly used from of axonometric projection for engineering drawings. The term "isometric" comes from the Greek for "equal measure."
- A **diametric projection** is a pictorial representation of an object where the direction of viewing has two of the three axes appearing equally foreshortened. The third axis is determined separately.
- A **trimetric projection** is a pictorial representation of an object where the direction of viewing has all three axes appearing unequally foreshortened.

Oblique Projection

An **oblique projection** is a method of drawing objects in three dimensions. It is a pictorial drawing method similar to isometric projection except two if its axes are perpendicular to each other so that one of its planes is parallel to the ground.

- **Cavalier** is a type of oblique projection where the receding side (depth) is scaled to actual size.
- **Cabinet** is a type of oblique projection where the receding side (depth) is half the actual size.
- **General** is a type of oblique projection where the receding side (depth) is two-thirds the actual size.

SIX PRINCIPAL VIEWS

Multiview projections are a major subdivision of orthographic projections. Multiview drawings used by CAD drafters show the object behind the plane of projection and the object is positioned such that only two of its dimensions are visible. A CAD drafter trained to interpret multiview drawings can visualize an object's 3D shape by studying the multiview drawings of that object. The method of visualizing multiviews is known as the glass box technique.

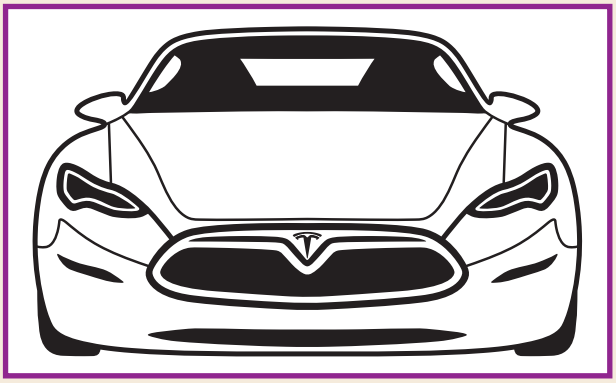
Glass Box Technique

The **glass box technique** is a method of visualizing a six-sided clear glass container and each side of the box is one of the six planes of projection used in multiview drawings. It is a visual aid used to define orthographic projection.

FURTHER EXPLORATION...

ONLINE CONNECTION:
How is CAD Connected to Tesla Automobiles?

Tesla, the maker of electric cars, used Autodesk's Alias Surface to streamline design and engineering processes. Alias Surface is used to visualize, render, surface, and draw. The software helped Tesla deliver high-quality designs in a very short period of time. Read the Autodesk Customer Success Story, "Electric Dreams Come True," at https://damassets.autodesk.net/content/dam/autodesk/files/Tesla_Motors_Customer_Story.pdf.



To perfect their plans, Tesla Motors create clay model designs using Autodesk Alias software to make rapid prototypes and CNC mills to produce the clay model designs.

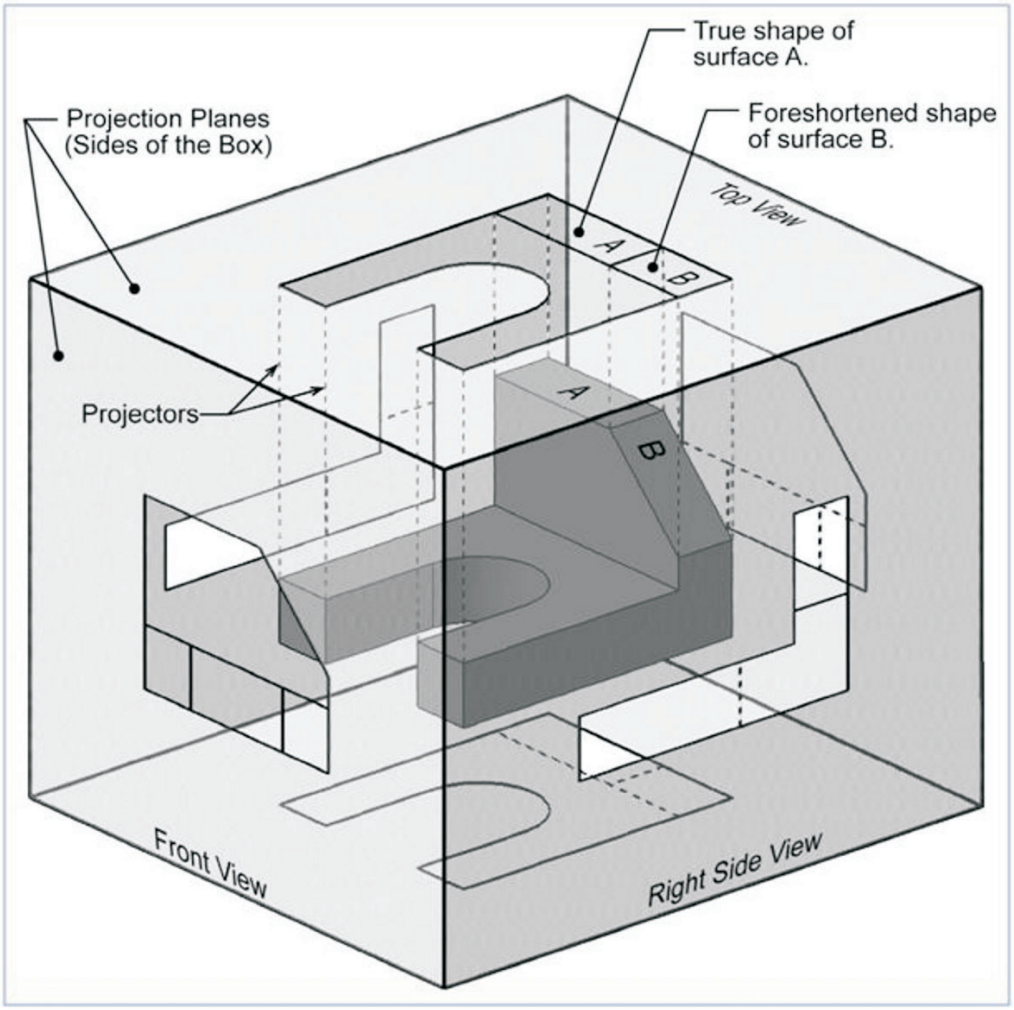


FIGURE 5. This image shows the glass box method of visualizing the six planes of projection. (Image Courtesy: Mark Smith, Industrial Technology Instructor, Reed-Custer High School, Braidwood, IL)

Projection Theory

Projection theory is the principles used to graphically represent 3D objects and structures onto the six sides of the glass box. All projection theory is based on two variables: line of sight and plane of projection.

- **Line of sight** is an imaginary ray of light between an observer's eye and an object.
- **Plane of projection** is an imaginary flat plane or surface (surface of one of the box sides) upon which the image created by the lines of sight is projected.

Six Principal Views

The **six principal views** in multiview orthographic projection drawings are front, back, top, bottom, left, and right side. Multiview drawings generally show three views of an object–often front, back, and side view–that show the features and dimensions in each view

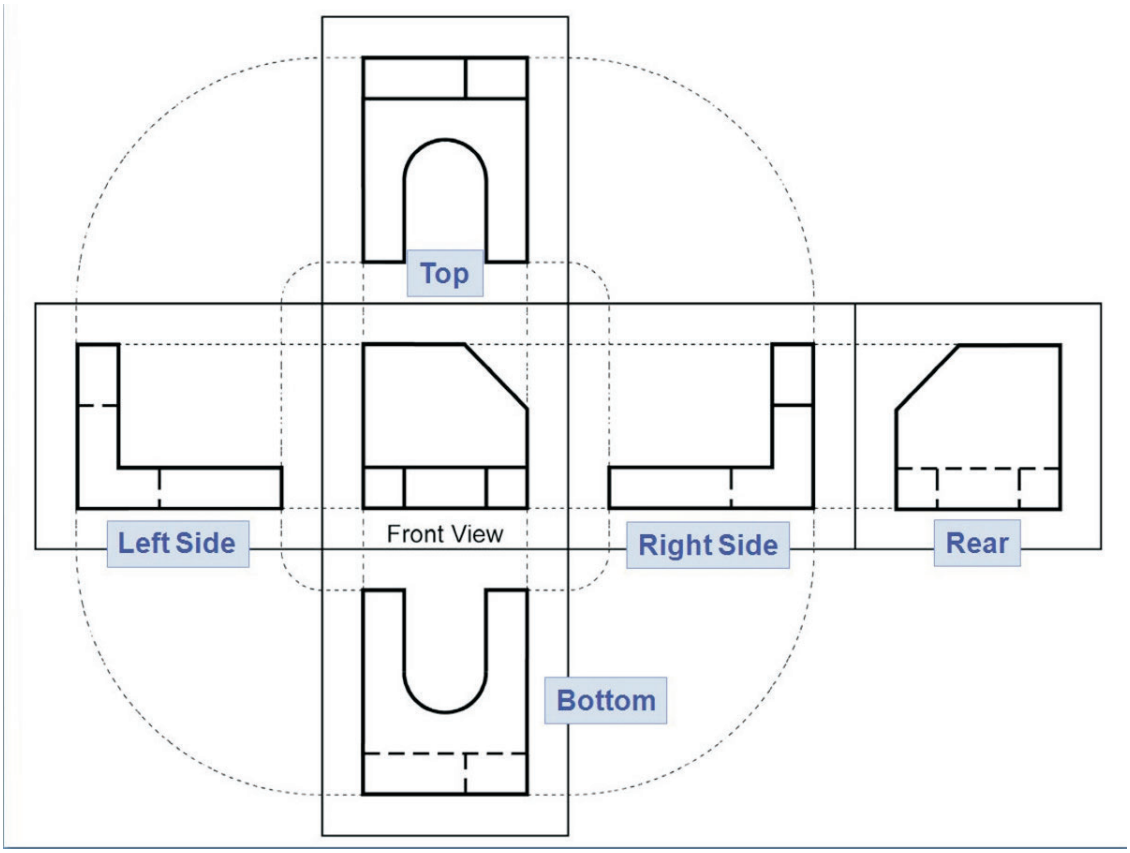


FIGURE 6. This image shows the unfolded glass box and the six planes of projection. (Image Courtesy: Mark Smith, Industrial Technology Instructor, Reed-Custer High School, Braidwood, IL)

that accurately represent those of the object. Each view is a 2D flat image. The views are defined according to the positions of the planes of projection with respect to the object. There are three principal dimensions of an object: width, height, and depth. For any object:

- The **front view** illustrates the width and height dimensions otherwise known as the frontal plane of projection. To determine which face of the object is the front view, the drafter considers that the front view should:
  - Represent the most natural position of use.
  - Contain the most characteristic shapes.
  - Have the longest dimensions.
  - Show the fewest hidden lines.
- The **back view** illustrates the depth and height dimensions.
- The **top view** illustrates the width and depth dimensions otherwise known as the horizontal plane of projection.
- The **bottom view** illustrates the width and depth dimensions otherwise known as the horizontal plane of projection.

- The **right side view** illustrates the depth and height dimensions otherwise known as the profile plane of projection. [NOTE: The right side view is the side view typically used in the United States.]
- The **left side view** illustrates the width and depth dimensions otherwise known as the profile plane of projection.

Line Precedence in CADD Drawings

Line precedence is the priority of lines in orthographic drawings. In order of importance:

- Continuous object lines take precedence over all other lines. Continuous lines (or object lines) are used to create the outline or the visible edges of an object.
- Hidden lines and cutting plane lines take precedence over centerlines. [NOTE: Hidden lines show the concealed features of an object.]
- Centerlines indicate the midpoint of symmetrical objects.
- Phantom lines are a series of long dashes separated by pairs of short dashes. Phantom lines indicate alternate positions of moving parts, repeated details, or referenced objects.

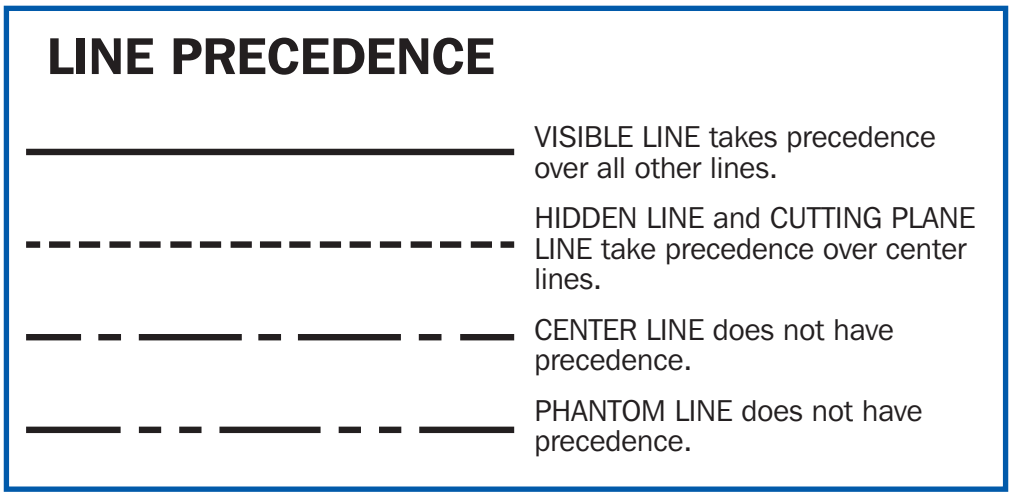


FIGURE 7. This image shows the priority that some lines have over other lines. (Image Courtesy: Mark Smith, Industrial Technology Instructor, Reed-Custer High School, Braidwood, IL)

Summary:

Orthographic projection is a common technique used to produce mechanical and architectural CAD drawings. Multiview orthographic projection drawings allow the drafter to represent a 3D drawing in a 2D environment. Multiview drawings can consist of up to six principal views: front, back, top, bottom, left side, and right side. Most multiview drawings have three principal views, but more views may be shown for complex objects with lots of details.

Checking Your Knowledge:

1. Describe orthographic multiview projections.
2. Differentiate between 1-, 2-, and 3-point perspective.
3. Explain the glass box method.
4. List and describe the six principal views.
5. Explain line precedence in a CAD/CADD drawing.

Expanding Your Knowledge:

Before starting your own orthographic multiview drawings, do some research online about what other companies are doing with orthographic projection and how they create multiview drawings. Ask for suggestions that you should consider when creating multiview drawings. Then, use the Web Links to preview and prepare to create multiview drawings.

Web Links:

2-Point Perspective Drawing Tutorial
http://www.automotiveillustrations.com/tutorials/drawing-2-point-perspective.html

Drawing in 3-Point Perspective
http://www.automotiveillustrations.com/tutorials/drawing-3-point-perspective.html

Ellipse Drawing Tutorial: Creating a Circle in Perspective
http://www.automotiveillustrations.com/tutorials/drawing-ellipse-in-perspective.html

Foreshortening Perspective Tutorial
http://www.automotiveillustrations.com/tutorials/perspective-foreshortened.html

The Glass Box Method
http://eon.sdsu.edu/~johnston/Eng_Graphics_Essentials_5th_Ed/files/ege/ortho/ortho_page2.htm

Isometric Drawing Tutorial
http://www.automotiveillustrations.com/tutorials/isometric-drawing-orthographic-projection.html